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DEPARTMENT OF CONSUMER AND INDUSTRY SERVICES

DIRECTOR'S OFFICE

OCCUPATIONAL HEALTH STANDARDS--LEAD

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These rules take effect 7 days after filing with the secretary of state

(By authority conferred on the director of the department of consumer and industry services by sections 14 and 24 of 1974 PA 154, MCL 408.1014 and 408.1024, and Executive Reorganization Order Nos. 1996-1 and 1996-2, MCL 330.3101 and 445.2001)

R 325.51904, R 325,51914, R 325.51917, R 325.51921, R 325.51930, and R 325.51958 of the Michigan Administrative Code are amended and R 325.51918 and R 325.51919 of the Michigan Administrative Code are rescinded as follows:

Bureau of Safety and Regulation, Standards Division Web Site: www.cis.state.mi.us/bsr/divisions/std

PART 310. LEAD

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R 325.51901 Scope and application.

Rule 1. These rules apply to all occupational exposures to lead, except that they do not apply to construction work or to agricultural operations.

R 325.51902 Definitions.

Rule 2. (1) As used in these rules:

(a) "Act" means Act No. 154 of the Public Acts of 1974, as amended, being §408.1001 et seq. of the Michigan Compiled Laws.

(b) "Action level" means employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter (30 ug/m^3) of air averaged over an 8-hour period.

(c) "Chelate" means a compound that will inactivate a metallic ion by forming an inner ring structure in the molecule whereby the metal ion becomes a member of the ring and the original ion is effectively out of action.

(d) "Department" means the department of consumer and industry services.

(e) "Director" means the director of the department or his or her designee.

(f) "Lead" means metallic lead, all inorganic lead compounds, and organic lead soaps. Lead does not include any other organic lead compound.

(g) "O.H. rule" means an occupational health rule incorporated by reference under section 14 of the act or promulgated under section 24 of the act. Copies of O.H. rules are available from the department.

(h) "Zinc protoporphyrin" or "ZPP" means the metabolite formed when a zinc molecule instead of an iron molecule combines with the protoporphyrin molecule. ZPP gives an indication of the biological effect of lead absorption on heme synthesis. Heme is the basic component of both hemoglobin, which functions in the transportation of oxygen from the lungs to the body cells, and the cytochromes, which function in the respiration of the individual cells.

(2) The terms defined in the act have the same meanings when used in these rules.

R 325.51903 Airborne concentrations; permissible employee exposure limits.

Rule 3. (1) An employer shall assure that an employee will not be exposed to lead at a concentration of more than 50 micrograms per cubic meter (50 ug/m^3) of air, averaged over an 8-hour period.

(2) If an employee is exposed to lead for more than 8 hours in any workday, then the permissible employee exposure limit as a time-weighted average for that day shall be reduced in accordance with formula A.

(3) Formula A reads as follows:

Maximum permissible employee exposure limit (in ug/m^3) = 400 hours ÷ hours worked in the day.

R 325.51904 Permissible employee exposure limit; use of respirators.

Rule 4. If respirators are used to supplement engineering and work practice controls to comply with the permissible employee exposure limit, and if all of the requirements of R 325.51917 have been met, then employee exposure, for the purpose of determining if an employer has complied with the permissible employee exposure limit, may be considered to be at the level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods the respirator is worn may be averaged with exposure levels during periods when respirators are not worn to determine an employee's daily time-weighted average exposure to lead.

R 325.51905 Exposure monitoring generally.

Rule 5. (1) For purposes of this rule and R 325.51906 to R 325.51913, employee exposure to lead shall be the exposure that might occur if an employee did not use a respirator.

(2) Except for exposure monitoring under R 325.51907, an employer shall collect personal samples that are representative of the full shift exposure for each worker for each shift in each work area in accordance with recognized industrial hygiene practices. As used in this subrule, "full shift" means not less than 7 continuous hours.

(3) Personal samples shall be representative of a monitored employee's regular daily exposure to lead.

R 325.51906 Exposure monitoring; initial determination.

Rule 6. An employer who has a workplace or work operation subject to these rules shall determine if an employee might be exposed to lead at or above the action level.

R 325.51907 Exposure monitoring; basis of initial determination.

Rule 7. An employer shall monitor employee exposures and shall base initial determinations on employee exposure monitoring results and on any of the following considerations:

(a) Information, observations, or calculations that would indicate employee exposure to lead.

(b) Previous measurements of airborne lead.

(c) Employee complaints of symptoms which may be attributable to exposure to lead.

(2) Monitoring for the initial determination may be limited to a representative sample of those exposed employees who an employer reasonably believes are exposed to the greatest airborne lead concentrations of lead in the workplace.

(3) Measurements of airborne lead concentrations made in the preceding 12 months may be used to satisfy the requirement to monitor pursuant to subrule (1) of this rule, if sampling and analytical methods used meet the accuracy and confidence levels required by R 325.51913.

R 325.51908 Exposure monitoring; positive initial determination.

Rule 8. (1) If a determination conducted under R 325.51906 and R 325.51907 shows the possibility of employee exposure to lead at or above the action level,

then an employer shall conduct monitoring that is representative of the exposure for each employee in the workplace who is exposed to lead.

(2) Measurements of airborne lead concentrations made in the preceding 12 months may be used to satisfy the requirement to monitor under subrule (1) of this rule if the sampling and analytical methods used meet the accuracy and confidence levels required by R 325.51913.

R 325.51909 Exposure monitoring; negative initial determination.

Rule 9. If a determination is made, pursuant to R 325.51906 and R 325.51907, that employees are not exposed to airborne concentrations of lead at or above the action level, an employer shall make a written record of that determination. The record shall include the information required pursuant to R 325.51907 and shall also include all of the following:

(a) The date of the determination.
(b) The job descriptions and location within the worksite.
(c) The name and social security number of each employee monitored.

R 325.51910 Exposure monitoring; frequency.

Rule 10. (1) If initial monitoring reveals employee exposure to be below the action level, the measurements need not be repeated, except as provided pursuant to R 325.51911.

(2) If an initial determination or subsequent monitoring reveals employee exposure to be at or above the action level, but below the permissible employee exposure limit, an employer shall repeat monitoring in accordance with this rule, R 325.51905 to R 325.51909, and R 325.51911 to R 325.51913 at least once every 6 months. The employer shall continue monitoring at the required frequency until not less than two consecutive measurements, taken not less than 7 days apart, are below the action level, at which time the employer may discontinue monitoring for that employee, except as provided pursuant to R 325.51911.

(3) If initial monitoring reveals that employee exposure is above the permissible employee exposure limit, an employer shall repeat monitoring quarterly. The employer shall continue monitoring at the required frequency until not less than two consecutive measurements, taken not less than 7 days apart, are below the permissible employee exposure limit, but at or above the action level. At that time, the employer shall repeat monitoring for that employee at the frequency prescribed by subrule (2) of this rule, except as otherwise provided pursuant to R 325.51911.

R 325.51911 Additional exposure monitoring.

Rule 11. If there has been a production, process, control or personnel change which might result in new or additional employee exposure to lead, or if an employer has any other reason to suspect a change which might result in new or additional exposures to lead, additional monitoring pursuant to R 325.51905 to R 325.51912, and R 325.51913 shall be conducted.

R 325.51912 Exposure monitoring; employee notification.

Rule 12. (1) Within 5 working days after the receipt of monitoring results, an employer shall notify each employee, in writing, of the results which represent that employee's exposure to lead.

(2) If the monitoring results indicate that employee exposure, without regard to respirators, exceeds the permissible employee exposure limit, an employer shall include in the written notice required by subrule (1) of this rule a statement that the permissible employee exposure limit was exceeded and a description of the corrective action taken or to be taken to reduce exposure to at or below the permissible employee exposure limit.

R 325.51913 Exposure monitoring; accuracy of measurement.

Rule 13. An employer shall use a method of monitoring and analysis which has an accuracy, to a confidence level of 95%, of not less than plus or minus 20% for airborne concentrations of lead equal to or greater than 30 micrograms per cubic meter (30 ug/m^3) of air.

R 325.51914 Methods of compliance; engineering and work practice controls.

Rule 14. (1) If an employee is exposed to lead above the permissible exposure limit for more than 30 days each year, then the employer shall implement engineering and work practice controls, including administrative controls, to reduce and maintain employee exposure to at or below 50 ug/m^3; except employers in the brass and bronze ingot manufacture industry and small non-ferrous foundries, who must reduce and maintain employee exposure to at or below 75 ug/m^3 in accordance with Table 1 of this rule, except to the extent that the employer can demonstrate that the controls are not feasible. If the engineering and work practice controls that can be instituted are not sufficient to reduce employee exposure to at or below the permissible exposure limit, then the employer shall use the controls to reduce exposures to the lowest feasible level and shall supplement the controls by using respiratory protection that is in compliance with the requirements of R 325.51917.

(2) If an employee is exposed to lead above the permissible exposure limit for 30 days or less each year, then the employer shall implement engineering controls to reduce exposures to at or below 200 ug/m^3, but thereafter may implement any combination of engineering, work practice, including administrative controls, and respiratory controls to reduce and maintain employee exposure to lead to at or below 50 ug/m^3.

(3) Table 1 reads as follows:

TABLE 1 - Implementation Schedule			
Industry	Compliance Dates		
	50 ug/m^3	75 ug/m^3	200 ug/m^3
Large Non-Ferrous Foundries	7/19/96[1]	N/A	N/A
Small Non-Ferrous Foundries	N/A	7/19/96[1]	N/A
Brass and Bronze Ingot Manufacture	N/A	6 years[2]	3/1/79[3]

[1] Large non-ferrous foundries that have 20 or more employees shall achieve 50 ug/m^3 by means of engineering and work practice controls. Small non-ferrous foundries that have fewer than 20 employees, however, are only required to achieve 75 ug/m^3 by means of engineering and work practice controls.

[2] Expressed as the number of years from the date on which the court lifts the stay on the implementation of paragraph 1910.1025(e)(1) of the Code of Federal Regulations for this industry for employers to achieve a lead-in-air concentration of 75 ug/m^3. Compliance with paragraph 1910.1025(e)(1) in this industry is determined by a compliance directive that incorporates the elements from the settlement agreement between OSHA and industry representatives.

[3] 7/28/84. This continues an obligation from table G-2 of O.H. rule 2103, which had been in effect since 1974, but which was deleted upon the effectiveness of this rule.

(4) If engineering and work practice controls do not reduce employee exposure to at or below the 50 micrograms per cubic meter (50 ug/m^3) of air permissible employee exposure limit, then an employer shall supplement the controls with respirators in accordance with the provisions of R 325.51917.

R 325.51915 Methods of compliance; compliance program.

Rule 15. (1) An employer shall establish and implement a written compliance program to reduce exposures to at or below the permissible employee exposure limit prescribed by R 325.51903, and interim levels if applicable, solely by means of engineering and work practice controls in accordance with the implementation schedule prescribed in R 325.51914.

(2) The written compliance program shall include at least all of the following:

(a) A description of each workplace operation in which lead is emitted, including, but not limited to, all of the following:
  (i) Machinery used.
  (ii) Material processed.
  (iii) Controls in place.
  (iv) Crew size.
  (v) Employee job responsibilities.
  (vi) Operating procedures.
  (vii) Maintenance practices.

(b) A description of the specific means that will be employed to achieve compliance, including engineering plans and studies used to determine methods selected for controlling exposure to lead.

(c) A report of the technology considered in meeting the permissible employee exposure limit.

(d) Air monitoring data which documents the source of lead emissions.

(e) A detailed schedule for implementation of the compliance program, including documentation of purchase orders for equipment, construction contracts, and other means of implementation.

(f) A work practice program which includes items required pursuant to R 325.51922 to R 325.51931a.

(g) An administrative control schedule required by R 325.51916b.

(h) Other relevant information.

(3) Written compliance programs shall be submitted, upon request, to the director and shall be available at the workplace for examination and copying by the director, an affected employee, or authorized employee representative.

(4) A written compliance program shall be revised and updated at least once every six months to reflect the current status of the compliance program.

R 325.51916 Rescinded. (03-04-98)

R 325.51916a Methods of compliance; mechanical ventilation.

Rule 16a. (1) If ventilation is used to control employee exposure, measurements which demonstrate the effectiveness of the ventilation system in controlling exposure, such as capture velocity, duct velocity, or static pressure, shall be made at least once every three months. Measurements of the ventilation system's effectiveness in controlling employee exposure shall be made within five days of any change in production, process or control which might result in a change in employee exposure to lead.

(2) If air from exhaust ventilation is recirculated into the workplace, the employer shall assure all of the following:

(a) The director has approved the air recirculation system.

(b) The ventilation system has a high efficiency filter with a reliable back-up filter.

(c) Controls are installed, operating, and maintained to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails.

R 325.51916b Methods of compliance; administrative controls.

Rule 16b. If administrative controls are used as a means to reduce an employee's time-weighted average exposure to lead, an employer shall establish and implement a job rotation schedule which shall include all of the following information:

(a) The name or identification number of each affected employee.

(b) The duration and exposure levels at each job or work station where each affected employee is located.

(c) Other information which may be useful in assessing the reliability of administrative controls to reduce employee exposure to lead.

R 325.51917 Respiratory protection.

Rule 17. (1) An employer shall provide respirators that comply with the requirements of these rules, for employees who use respirators required by this subrule. An employer shall ensure that an employee uses a respirator during all of the following:

(a) Periods necessary to install or implement engineering or work practice controls.

(b) Work operations for which engineering and work practice controls are not sufficient to reduce employee exposures to or below the permissible employee exposure limit.

(c) Periods when an employee requests a respirator.

(2) An employer shall implement a respiratory protection program in accordance with 29 C.F.R. 1910.134 (b) to (d) and (f) to (m), except for (d)(1)(iii), as adopted by reference in the respiratory protection standard, being R 325.60051 et seq. of the Michigan Administrative Code.

(3) If an employee has breathing difficulty during fit testing or respirator use, then the employer shall provide the employee with a medical examination in accordance with R 325.51937(c) to determine whether or not the employee can use a respirator while performing the required duty.

(4) An employer shall select the appropriate respirator or combination of respirators as set forth in table 2.

Table 2
Respiratory Protection for Lead Aerosols

Airborne Concentration of Lead or Condition of Use	Required Respirator[1]
Not more than 500 ug/m^3 (10 x PEL)	Half-mask, air-purifying respirator equipped with high-efficiency filters.[2,3]
Not more than 2500 ug/m^3 (50 x PEL)	Full facepiece, air-purifying respirator with high-efficiency filters.[3]
Not more than 50,000 ug/m^3 (1000 x PEL)	(1) Any powered, air-purifying respirator with high-efficiency filters.[3] (2) Half-mask, supplied-air respirator operated in positive pressure mode.[2]
Not more than 100,000 ug/m^3 (2000 x PEL)	Supplied-air respirators with full facepiece, hood, helmet, or suit operated in positive pressure mode.
More than 100,000 ug/m^3, unknown concentration, or fire fighting	Full facepiece, self-contained breathing apparatus operated in positive pressure mode.

[1] Respirators specified for high concentrations may be used at lower concentrations of lead.
[2] A full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.
[3] A high-efficiency particulate filter means 99.97% efficient against 0.3 micron size particles. N, R, or P--100 designated filters are acceptable.

(5) An employer shall provide a powered, air-purifying respirator instead of the respirator specified in table 2 of this rule when an employee chooses to use this type of respirator and such a respirator provides adequate protection to the employee.

R 325.51918 Rescinded. (10/12/00)

R 325.51919 Rescinded. (10/12/00)

R 325.51920 Rescinded. (10/12/00)

R 325.51921 Filter elements and employee washing.

Rule 21. (1) An employer shall permit an employee who uses a filter respirator to change the filter elements when an increase in breathing resistance is detected. An employer shall maintain an adequate supply of filter elements for this purpose.

(2) An employer shall permit an employee who wears a respirator to leave work areas to wash his or her face and respirator facepiece when necessary to prevent skin irritation associated with respirator use.

R 325.51922 Protective work clothing and equipment; provision and use.

Rule 22. If an employee is exposed to lead above the permissible employee exposure limit prescribed by R 325.51903, without regard to the use of respirators, or if the possibility of skin or eye irritation exists, an employer shall provide, at no cost to the employee, and shall assure that the employee uses, appropriate protective work clothing and equipment, including all of the following:

(a) Coveralls or similar full-body work clothing.

(b) Gloves, hats, and shoes or disposable shoe coverings.

(c) Face shields, vented goggles or other appropriate protective equipment which complies with R 408.13501 to R 408.13569.

R 325.51923 Protective work clothing and equipment; cleaning and replacement.

Rule 23. (1) An employer shall provide employees with the protective clothing required pursuant to R 325.51922 in a clean and dry condition at least once each week. For employees who are exposed to airborne concentrations of lead, without regard to the use of a respirator, greater than 200 micrograms per cubit meter (200 ug/m^3) of air as an 8-hour, time-weighted average, protective clothing in a clean and dry condition shall be provided at least once each day.

(2) An employer shall provide for the cleaning, laundering or disposal of protective clothing and equipment required pursuant to R 325.51922.

(3) An employer shall repair or replace required protective clothing and equipment as often as needed to maintain the effectiveness of the clothing and equipment.

(4) An employer shall assure both of the following:

(a) That an employee removes all protective clothing at the completion of a work shift and only in a change room of the type described in R 325.51929.
(b) That contaminated protective clothing which is to be cleaned, laundered, or disposed of is placed in a closed container which prevents the dispersion of lead outside of the container.

R 325.51924 Protective work clothing and equipment; modification; labeling of containers.

Rule 24. (1) An employer shall inform a person who cleans or launders protective clothing or equipment, in writing, of the potentially harmful effects of exposure to lead.

(2) An employer shall prohibit the removal of lead from protective clothing or equipment by blowing, shaking or other methods which may disperse lead into the air.

(3) An employer shall assure that containers of contaminated protective clothing and equipment required pursuant to R 325.51923(4)(b) are labeled. The labels shall bear the following legend:

CAUTION:

CLOTHING OR EQUIPMENT CONTAMINATED WITH LEAD.

DO NOT REMOVE DUST BY BLOWING OR SHAKING.

DISPOSE OF LEAD CONTAMINATED WASH WATER.

IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE, OR LOCAL REGULATIONS.

R 325.51925 Housekeeping; workplace surfaces.

Rule 25. Surfaces in a workplace shall be maintained as free as practicable from accumulations of lead.

R 325.51926 Housekeeping; floor cleaning; vacuuming.

Rule 26. (1) Floors and other surfaces where lead may accumulate in a workplace shall not be cleaned with the use of compressed air.

(2) Shoveling, dry or wet sweeping, and brushing may be used for cleaning a workplace only if vacuuming or other equally effective methods have been tried and found not to be effective in removing lead accumulations.

(3) If vacuuming methods are selected for cleaning a workplace, a vacuum shall be used and emptied in a manner which minimizes the reentry of lead into the workplace.

R 325.51927 Rescinded. (03/04/98)

R 325.51928 Prohibition of certain types of personal items in lead work areas.

Rule 28. An employer shall assure that food or beverages are not present or consumed, tobacco products are not present or used, and cosmetics are not applied in areas where employees are exposed to lead concentrations greater than the permissible employee exposure limit prescribed by R 325.51903. These prohibitions do not apply in change rooms, lunchrooms or showers.

R 325.51929 Hygiene facilities; change rooms.

Rule 29. (1) An employer shall provide clean change rooms for employees who work in areas where airborne exposures to lead are greater than the permissible employee exposure limit prescribed by R 325.51903, without regard to the use of respirators.

(2) An employer shall equip change rooms with separate storage or locker facilities for protective work clothing and equipment under R 325.51922 and for street clothes that prevent cross-contamination.

R 325.51930 Hygiene facilities; showers.

Rule 30. (1) An employer shall ensure that employees who work in areas where airborne exposures to lead are greater than the permissible employee exposure limit prescribed by R 325.51903, without regard to the use of respirators, shower at the end of each work shift.

(2) An employer shall provide shower facilities in accordance with O.H. rule 4201 (4)(c), sanitation.

(3) An employer shall ensure that an employee who is required to shower under subrule (1) of this rule does not leave the workplace wearing any of the protective work clothing or equipment required under R 325.51922 or other significantly contaminated clothing.

R 325.51931 Hygiene facilities; lunchrooms.

Rule 31. (1) An soon as possible, but not later than July 28, 1985, lunchroom facilities shall be provided by an employer for employees who work in areas where airborne exposures to lead are greater than the permissible employee exposure limit prescribed by R 325.51903, without regard to the use of respirators.

(2) The employer shall assure that lunchroom facilities have a temperature-controlled, positive-pressure, filtered air supply, unless the lunchroom facilities are remote from the lead work area such that lead contamination is not possible, and shall assure that the facilities are readily accessible to employees.

(3) Employees whose work causes significant hand or face lead contamination shall be required to wash the contaminated skin areas prior to applying cosmetics, eating, drinking or smoking.

(4) Employees shall not enter lunchroom facilities with protective work clothing or equipment until surface lead dust has been removed by vacuuming, downdraft booth, or other appropriate cleaning method.

R 325.51931a Washing facilities.

Rule 31a. An employer shall provide an adequate number of washing facilities that are in compliance with O.H. rule 4201(4)(a) and (b).

R 325.51932 Medical surveillance generally.

Rule 32. (1) An employer shall institute a medical surveillance program for each employee who is or may be exposed to concentrations of lead greater than the action level for more than 30 days a year.

(2) A licensed physician or someone under the supervision of a licensed physician shall establish procedures for, and shall perform, medical examinations.

(3) An employer shall provide the required medical surveillance at a convenient time and place, without cost to employees.

(4) An employer shall give priority for biological monitoring and medical examinations shall be provided to employees who the employer believes are at the greatest risk from continued exposure to lead.

R 325.51933 Medical surveillance; biological monitoring; blood lead and zinc protoporphyrin (ZPP) level sampling and analysis.

Rule 33. An employer shall make available biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels to each employee who is or may be exposed to concentrations of lead greater than the action level for more than 30 days a year in accordance with the following schedule:

(a) At least once every 6 months for each employee.
(b) At least once every 2 months for each employee whose blood sample and analysis indicated a blood lead level at or above 40 micrograms per 100 grams

(40 ug/100 g) of whole blood. The 2-month frequency shall continue until 2 consecutive blood samples and analyses indicate a blood level below 40 micrograms per 100 grams (40 ug/100 g) of whole blood.

(c) At least monthly during the period of time an employee is removed from exposure to lead due to an elevated blood lead level.

R 325.51934 Medical surveillance; biological monitoring follow-up blood sampling tests.

Rule 34. If the results of a blood level test indicate that an employee's blood lead level exceeds the numerical criterion for medical removal under R 325.51943, then an employer shall provide a second (follow-up) blood sampling test within 2 weeks after the results of the first blood sampling test are received.

R 325.51935 Medical surveillance; biological monitoring; accuracy of blood lead level sampling and analysis.

Rule 35. Blood lead level sampling and analysis provided pursuant to R 325.51933 and R 325.51934 shall have an accuracy to a confidence level of 95% within plus or minus 15% or 6 micrograms per 100 milliliters (6 ug/100 ml), whichever is greater. Sample analyses shall be conducted by a laboratory licensed or approved by the center for disease control, United States department of health and human services or which has received a satisfactory grade in blood lead proficiency testing from the center for disease control in the prior 12 months.

R 325.51936 Medical surveillance; biological monitoring; employee notifications.

Rule 36. Within 5 working days after the receipt of biological monitoring results, an employer shall notify each employee, in writing, whose blood lead level exceeds 40 micrograms per 100 grams (40 ug/100 g) of whole blood of both of the following:

(a) The employee's blood lead level.

(b) That these rules require temporary medical removal with medical removal protection benefits when an employee's blood lead level exceeds the numerical criterion for medical removal pursuant to R 325.51943.

R 325.51937 Medical surveillance; medical examinations and consultations; frequency.

Rule 37. An employer shall make available medical examinations and consultations to each employee who is or may be exposed to concentrations of lead greater than the action level for more than 30 days a year according to the following schedule:

(a) At least annually for each employee for whom a blood sampling test conducted at any time during the previous 12 months indicated a blood lead level at or above 40 micrograms per 100 grams (40 us/100 g) of whole blood.

(b) Prior to an employee's being assigned for the first time to an area in which airborne concentrations of lead are at or above the action level.

(c) As soon as possible after notification by an employee that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice concerning the effects of current or past exposure to lead on the employee's ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing either during a respirator fitting test or during use of a respirator.

(d) As medical appropriate for an employee who is either removed from exposure to lead due to a risk of sustaining material impairment to health or who is otherwise limited pursuant to a final medical determination.

R 325.51938 Medical surveillance; medical examinations and consultations; content.

Rule 38. (1) A medical examination made available pursuant to R 325.51937(a) and (b) shall include all of the following elements:

(a) A detailed work history and a medical history, with particular attention to past occupational and non-occupational lead exposure; personal hematological, renal, cardiovascular, reproductive and neurological problems.

(b) A thorough physical examination, with particular attention to teeth, gums, and hematological, gastrointestinal, renal, cardiovascular, and neurological status. Pulmonary status shall be evaluated if respiratory protection is to be used.

(c) A blood pressure measurement.

(d) A blood sample and an analysis which determines all of the following:

(i) Blood lead level.

(ii) Hemoglobin and hematocrit determinations, red cell indices, and examination of peripheral and smear morphology.

(iii) Blood urea nitrogen.

(iv) Serum creatinine.

(e) A routine urinalysis with microscopic examination.

(f) A laboratory or other test which an examining physician deems necessary by sound medical practice.

(2) The contents of a medical examination made available pursuant to R 325.51937(c)and (d) shall be determined by an examining physician and, if requested by an employee, shall include pregnancy testing or laboratory evaluation of male fertility, as the case may be.

R 325.51938a Medical surveillance; medical examinations and consultations; multiple physician review.

Rule 38a. (1) If an employer selects the initial physician to conduct a medical examination or consultation provided to an employee pursuant to R 325.51937 and R 325.51938, an employee may designate a second physician to do both of the following:

(a) Review the findings, determinations or recommendations of the initial physician.

(b) Conduct examinations, consultations and laboratory tests as the second physician deems necessary to facilitate his or her review of the findings, determinations or recommendations of the initial physician.

(2) An employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that a physician selected by the employer conducts a medical examination of consultation pursuant to R 325.51937 and R 325.51938.

(3) An employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing both of the following within 15 days after receipt of the employer's notification, as required in subrule (2) of this rule, or receipt of the initial physician's written opinion, whichever is later:

(a) The employee informs the employer that he or she intends to seek a second medical opinion.

(b) The employee initiates steps to make an appointment with a second physician.

(4) If the findings, determinations or recommendations of a second physician differ from those of an initial physician, the employee and the employer shall assure that efforts are made for the 2 physicians to resolve the disagreement. If the 2 physicians are unable to quickly resolve the disagreement the employer and employee, through their respective physicians, shall designate a third physician to do both of the following:

(a) Review the findings, determinations or recommendations of the prior physicians.

(b) Conduct examinations, consultations, laboratory tests and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement between the prior physicians.

(5) The employer shall act consistent with the findings, determinations, and recommendations of the third physician, unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least 1 of the 3 physicians.

R 325.51939 Medical surveillance; medical examinations and consultations; information provided to examining and consulting physicians.

Rule 39. (1) An employer shall provide a physician conducting a medical examination or consultation pursuant to R 325.51937 and R 325.51938 with all of the following information:

(a) A copy of these rules and their appendices.

(b) A description of an affected employee's duties as they relate to the employee's exposure to lead.

(c) An employee's lead exposure level or anticipated lead exposure level and an employee's actual or anticipated exposure level to any other toxic substance, if applicable.

(d) A description of personal protective equipment used or to be used.

(e) An employee's prior blood lead determination.

(f) All prior written medical opinions in the employer's possession or control concerning an employee.

(2) Upon request by the other physician or by an employee, the employer shall provide the information required by subrule (1) of this rule to another physician conducting a medical examination pursuant to these rules.

R 325.51940 Medical surveillance; examinations and consultations; written medical opinions.

Rule 40. (1) An employer shall obtain, and provide an employee with a copy of, a written medical opinion from each examining or consulting physician which shall contain all of the following information:

(a) The physician's opinion as to whether the employee has a detected medical condition which would place the employee at an increased risk of material impairment of the employee's health from exposure to lead.

(b) Any recommended special protective measures to be provided to the employee or limitations to be placed upon the employee's exposure to lead.

(c) Any recommended limitation upon the employee's use of respirators, including a determination of whether the employee can wear a powered air-purifying respirator if a physician determines that the employee cannot wear a negative pressure respirator.

(d) The results of the blood lead determinations.

(2) An employer shall instruct each examining and consulting physician to do each of the following:

(a) Not reveal, in the written opinion or in other means of communication with the employer, findings, laboratory results or diagnoses unrelated to an employee's occupational exposure to lead.

(b) Advise the employee of any occupational or non-occupational medical condition which dictates further medical examination or treatment.

R 325.51941 Medical surveillance; medical examinations and consultations; alternate physician determination.

Rule 41. An employer and an employee or authorized employee representative, with the written approval of the employee in question, may agree upon the use of an expeditious alternate physician determination, instead of the multiple physician review mechanism provided in R 325.51938a, if the alternate physician determination otherwise satisfies the requirements of these rules.

R 325.51942 Chelation.

Rule 42. (1) A person retained, employed, supervised or controlled by an employer shall not engage in prophylactic chelation of an employee at any time.

(2) If therapeutic or diagnostic chelation is to be performed by a person retained, employed, supervised or controlled by an employer, the employer shall assure that the chelation shall be carried out under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring and that the employee is notified in writing and that the employee consents thereto in writing prior to its occurrence.

R 325.51943 Medical removal protection; temporary medical removal; elevated blood lead levels.

Rule 43. (1) An employer shall remove an employee from work who has an exposure to lead at or above the action level on each occasion that a periodic blood sampling test and a follow-up blood sampling test conducted under these rules indicate that the employee's blood lead level is at or above 60 micrograms per 100 grams (60 ug/l00 g) of whole blood.

(2) An employer shall remove an employee from work if the employee has an exposure to lead at or above the action level on each occasion that the average of the last 3 blood sampling tests conducted under these rules, or the average of all blood sampling tests conducted over the previous 6 months, whichever is longer, indicates that the employee's blood lead level is at or above 50 micrograms per 100 grams (50 ug/l00 g) of whole blood. However, an employee shall not be required to be removed if the last blood sampling test indicates a blood lead level at or below 40 micrograms per 100 grams (40 ug/l00 g) of whole blood.

R 325.51944 Medical removal protection; temporary medical removal; final medical determination.

Rule 44. (1) For purposes of this rule, "final medical determination" means the outcome of a multiple physician review made pursuant to R 325.51938a.

(2) An employer shall remove from work an employee who has an exposure to lead at or above the action level on each occasion that a final medical determination results in a medical finding, determination or opinion that the employee has a detected medical condition which places the employee at an increased risk of material impairment to health from exposure to lead.

(3) If a final medical determination results in any recommended special protective measures for an employee or limitation on an employee's exposure to lead, an employer shall implement and act consistently with the recommended protective measures.

R 325.51945 Medical removal protection; return of an employee to former job status.

Rule 45. (1) An employer shall return an employee to his or her former job status under any of the following circumstances:

(a) For an employee removed due to a blood lead level at or above 70 micrograms per 100 grams (70 ug/100 g) of whole blood, when 2 consecutive blood sampling tests indicate that the employee's blood lead level is at or below 50 micrograms per 100 grams (50 ug/100 g) of whole blood.

(b) For an employee removed due to a blood lead level at or above 60 micrograms per 100 grams (60 ug/100 g) of whole blood or due to an average blood lead level at or above 50 micrograms per 100 grams (50 ug/100 g) of blood, when 2 consecutive blood sampling tests indicate that the employee's blood lead level is at or below 40 micrograms per 100 grams (40 ug/100 g) of whole blood.

(c) For an employee removed due to a final medical determination, when a subsequent final medical determination results in a medical finding, determination or opinion that the employee no longer has a detected medical condition which places the employee at an increased risk of material impairment to health from exposure to lead.

(2) For purposes of this rule, the requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had, absent temporary medical removal, to a specific job classification or position under the terms of a collective bargaining agreement.

R 325.51946 Medical removal protection; removal of other employee protective measures or limitations.

Rule 46. An employer shall remove any limitations placed on an employee or shall terminate any special protective measures provided to an employee pursuant to a determination when a subsequent final medical determination indicates that the limitations or special protective measures are no longer necessary.

R 325.51947 Medical removal protection; employer options pending final medical determinations.

Rule 47. If a multiple physician review used pursuant to R 325.51938a has not resulted in a final medical determination with respect to an employee, an employer may do either of the following:

(a) Remove the employee from exposure to lead, provide special protective measures to the employee or place limitations upon the employee consistent with the medical findings, determinations or recommendations of any of the physicians who have reviewed the employee's health status.

(b) Return the employee to his or her former job status, end any special protective measures provided to the employee and remove any limitations placed upon the employee consistent with the medical findings, determinations or recommendations of any of the physicians who have reviewed the employee's health status, except as follows:

(i) If the initial removal, special protection or limitation of the employee resulted from a medical determination which differed from the findings, determinations or recommendations of the initial physician, the employer shall await a final medical determination.

(ii) If the employee has been on removal status for the preceding 18 months due to an elevated blood lead level, the employer shall await a final medical determination.

R 325.51948 Medical removal protection benefits.

Rule 48. (1) For purposes of these rules, the requirement that an employer provide medical removal protection benefits means that the employer shall maintain the earnings, seniority and other employment rights and benefits of an employee as though the employee had not been removed from normal exposure to lead or had not been otherwise limited. Medical removal benefits shall not replace employee earnings and shall not be related to the cost of medical treatment for which the employee remains responsible, that is not lead related.

(2) An employer shall provide to an employee up to 18 months of medical removal protection benefits on each occasion that an employee is removed from exposure to lead or is otherwise limited pursuant to this rule.

(3) During the time that an employee is removed from normal exposure to lead or is otherwise limited an employer may condition the provision of medical removal protection benefits upon the employee's participation in follow-up medical surveillance made available pursuant to this rule.

(4) If a removed employee files a claim for workers' compensation payments for a lead-related disability, the employer shall continue to provide medical removal protection benefits pending disposition of the claim. To the extent that an award is made to the employee for earnings lost during the period of removal, the employer's medical removal protection obligation shall be reduced by that amount. The employer shall not receive credit for workers' compensation payments received by the employee for treatment-related expenses.

(5) An employer's obligation to provide medical removal protection benefits to a removed employee shall be reduced to the extent that an employee receives compensation for earnings lost during the period of removal from either a publicly or employer-funded compensation program or from employment with another employer made possible by virtue of the employee's removal.

(6) An employer shall take both of the following measures with respect to an employee removed from exposure to lead due to an elevated blood lead level has not declined within the past 18 months of removal so that the employee has been returned to his or her former job status:

(a) Make available to the employee a medical examination pursuant to these rules to obtain a final medical determination with respect to the employee.

(b) Assure that the final medical determination has not yet been obtained or, if obtained, indicates the employee may be returned to his or her former job status and, if not, the steps which are to be taken to protect the employee's health.

(7) If a final medical determination has not yet been obtained or, if obtained, indicates that the employee may not yet be returned to his or her former job status, the employer shall continue to provide medical removal protection benefits to the employee until either the employee is returned to his or her former job status or until a final medical determination is made that the employee is incapable of ever safely returning to his or her former job status.

(8) If an employer acts pursuant to a final medical determination which permits the return of an employee to his or her former job status despite what would otherwise be an unacceptable blood lead level, later determinations concerning removal of the employee shall be decided by a final medical determination. An employer shall not be required to automatically remove that employee pursuant to the blood lead level removal criteria provided by these rules until a final medical determination is made.

(9) If an employer, whether or not required by this rule, removes an employee from exposure to lead or otherwise places limitations on an employee due to the effects of lead exposure on the employees' medical condition, the employer shall provide medical removal protection benefits to the employee equal to that required by subrule (2) of this rule.

R 325.51949 Employee information and training; training program.

Rule 49. (1) An employer who has a workplace in which there is a potential exposure to airborne lead at any level shall inform employees of the contents of Appendices A to 29 C.F.R. §1910.1025, Substance Data Sheet for Occupational Exposure to Lead, and B to 29 C.F.R. §1910.1025, Employee Standard Summary. Appendices A and B are adopted by reference in R 325.51958.

(2) An employer shall institute a training program for, and assure participation by, all employees who are subject to exposure to lead at or above the action level or for whom the possibility of skin or eye irritation exists from exposure to lead.

(3) An employer shall provide initial training in accordance with both of the following provisions:

(a) Within 180 days from the effective date of these rules for employees subject to subrule (2) of this rule.

(b) For new employees who subsequently become subject to subrule (2) of this rule, before the time of initial job assignment.

(4) The training program shall be repeated at least annually for each employee.

(5) An employer shall assure that each employee is informed of all of the following information:

(a) The contents of these rules and appendices.

(b) The specific nature of the operations that could result in exposure to lead above the action level.

(c) The purpose, proper selection, fitting, use, and limitations of respirators.

(d) The purpose and a description of the medical surveillance program and the medical removal protection program, including information regarding adverse health effects associated with excessive exposures to lead, with particular attention to the adverse reproductive effects on both males and females.

(e) The engineering controls and work practices associated with the employee's job assignment.

(f) The contents of any compliance plan in effect.

(g) Instructions to employees that chelating agents shall not routinely be used to remove lead from their bodies and shall not be used at all except under the direction of a licensed physician.

R 325.51950 Employee information and training; access to information and training materials.

Rule 50. (1) An employer shall make a copy of these rules and their appendices readily available to all affected employees.

(2) Upon request, an employer shall provide to the director all materials relating to the employee information and training program.

(3) In addition to the information required by R 325.51949(5), an employer shall include as part of the training program, and shall distribute to employees, all materials pertaining to the act and the rules promulgated thereunder which are provided to the employer by the department.

R 325.51950a Signs generally.

Rule 50a. (1) An employer may use signs required by other statutes, rules, regulations or ordinances in addition to, or in combination with, signs required by R 325.51950b.

(2) An employer shall assure that no statement appears on or near any sign required by R 325.51950b which contradicts or detracts from the meaning of the required sign.

R 325.51950b Sign requirements.

Rule 50b. (1) An employer shall post the following warning sign in each work area where the permissible employee exposure limit is exceeded:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

(2) An employer shall assure that signs required by this rule are illuminated and cleaned as necessary so that the legend is readily visible.

R 325.51951 Recordkeeping; exposure monitoring.

Rule 51. (1) An employer shall establish and maintain an accurate record of all monitoring required pursuant to R 325.51905 to R 325.51913.

(2) The monitoring records shall include all of the following:

(a) The date or dates, number, duration, locations and results in each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure, where applicable.

(b) A description of the sampling and analytical methods used and evidence of their accuracy.

(c) The type of respiratory protective devices worn, if any.

(d) The name, social security number and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent.

(e) The environmental variables that could affect the measurement of employee exposure.

(3) An employer shall maintain monitoring records for not less than 40 years or for the duration of employment plus 20 years, whichever is longer.

R 325.51952 Recordkeeping; medical surveillance.

Rule 52. (1) An employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by R 325.51932 to R 325.51942.

(2) The medical surveillance record shall include all of the following:

(a) The name, social security number and description of the duties of the employee.

(b) A copy of the physicians' written opinions.

(c) Results of any airborne exposure monitoring carried out for that employee and the representative exposure levels supplied to the employee's physician or physicians.

(d) Employee medical complaints related to exposure to lead.

(3) An employer shall maintain, or assure that the examining physician maintains, all of the following medical records:

(a) A copy of the medical examination results including medical and work history required pursuant to R 325.51932 to R 325.51942.

(b) A description of the laboratory procedures and a copy of standards or guidelines used to interpret test results or references to that information.

(c) A copy of the results of biological monitoring.

(4) An employer shall maintain, or assure that the physician maintains, medical records for not less than 40

years or for the duration of employment plus 20 years, whichever is longer.

R 325.51953 Recordkeeping; medical removals.

Rule 53. (1) An employer shall establish and maintain an accurate record for each employee removed from exposure to lead pursuant to R 325.51943 to R 325.51948.

(2) Each medical removal record shall include all of the following:

(a) The name and social security number of the employee.

(b) The date on each occasion that the employee was removed from current exposure to lead and the corresponding date on which the employee was returned to his or her former job status.

(c) A brief explanation of how each removal was or is being accomplished.

(d) With respect to each removal, a statement indicating whether the reason for the removal was an elevated blood lead level.

(3) The employer shall maintain a medical removal record for at least the duration of an employee's employment.

R 325.51954 Availability of records.

Rule 54. (1) Upon request, an employer shall make all records to be maintained pursuant to R 325.51951 to R 325.51953 available to the director for examination and copying.

(2) Upon request, an employer shall make environmental monitoring, biological monitoring and medical removal records available for examination and copying to affected employees, former employees or authorized employee representatives.

(3) Upon request, an employer shall make an employee's medical records required to be maintained by this rule available for examination and copying to an affected employee, former employee, physician or other individual designated by an affected employee or former employee.

R 325.51955 Transfer of records.

Rule 55. (1) If an employer ceases to do business and there is a successor employer, the successor employer shall receive and retain all records required to be maintained pursuant to R 325.51951 to R 325.51953.

(2) If an employer ceases to do business and there is no successor employer to receive and retain the records required to be maintained for the prescribed period by R 325.51951 to R 325.51953, the records shall be transmitted to the director.

(3) At the expiration of the retention period for the records required to be maintained by R 325.51951 to R 325.51953, an employer shall notify the director not less than 3 months prior to the disposal of the records. The employer shall transmit the records to the director, upon request, within the 3-month period.

R 325.51956 Observation of monitoring; employee observation.

Rule 56. An employer shall provide affected employees or their designated representatives an opportunity to observe monitoring of employee exposure to lead conducted pursuant to R 325.51905 to R 325.51913.

R 325.51957 Observation of monitoring; procedures.

Rule 57. (1) If observation of the monitoring of employee exposure to lead requires entry into an area where the use of respirators, protective clothing or equipment is required an employer shall provide the observer with, and assure the use of, respirators, protective clothing and equipment and shall require the observer to comply with all other applicable safety and health procedures.

(2) Without interfering with the monitoring, an observer shall be entitled to all of the following:

(a) Receipt of an explanation of the measurement procedures.

(b) Observation of all steps related to the monitoring of lead performed at the place of exposure.

(c) To record the results obtained or to receive copies of the results when returned by the laboratory.

R 325.51958 Adoption of appendices by reference; availability of rules and appendices; permission to reproduce.

Rule 58. (1) The provisions of Appendixes A and B to 29 C.F.R. §1910.1025 are adopted by reference in these rules. Appendices A and B to these rules are exact copies of appendices A and B to 29 C.F.R. §1910.1025.

(2) The provisions of appendix C is informational and not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

(3) A copy of these rules and related appendices, which are titled "Appendix A--Substance Data Sheet for Occupational Exposure to Lead," "Appendix B--Employee Standard Summary," and "Appendix C--Medical Surveillance Information," are available to affected employers and employees at no cost as of the time of adoption of these rules from the Michigan Department of Consumer and Industry Services, 7150 Harris Drive, P. O. Box 30643, Lansing, Michigan 48909-8143. Copies of appendices A and B of 29 C. F. R. §1910.1025 may also be obtained from the United States Department of Labor, OSHA Area Office, 801 S. Waverly Road, Lansing, Michigan 48917, at no cost as of the time of adoption of these rules.

(4) Permission to reproduce any of these documents in full is granted by the director.

APPENDICES TO MIOSHA STANDARD FOR LEAD (R 325.51901-R 325.51958)

APPENDIX A
SUBSTANCE DATA SHEET FOR OCCUPATIONAL EXPOSURE TO LEAD

Contents:

I. Substance Identification

A. Substance: Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

B. Compounds Covered by the Standard: The word "lead" when used in this standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

C. Uses: Exposure to lead occurs in at least 120 different occupations, including primary and secondary lead smelting, lead storage battery manufacturing, lead pigment manufacturing and use, solder manufacturing and use, shipbuilding and ship repairing, auto manufacturing, and printing.

D. Permissible Exposure: The Permissible Exposure Limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air (50 ug/m^3), averaged over an 8-hour work-day.

E. Action Level: The standard establishes an action level of 30 micrograms per cubic meter of air (30 ug/m^3), time weighted average, based on an 8-hour work-day. The action level initiates several requirements of the standard, such as exposure monitoring, medical surveillance, and training and education.

II. Health Hazard Data

A. Ways in which lead enters your body. When absorbed into your body in certain doses lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed.

Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume or mist it can be inhaled and absorbed through your lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion.

A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

B. Effects of overexposure to lead: (1) Short-term (acute) overexposure. Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise which develops quickly to seizures, coma, and death from cardiorespiratory arrest. A short-term dose of lead can lead to acute encephalopathy. Short term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead and chronic effects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease which arise after periods of exposure as short as days or as long as several years.

(2) Long-term (chronic) overexposure. Chronic overexposure to lead may result in severe damage to your blood-forming, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain.

Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy.

Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since the lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood.

Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

(3) Health protection goals of the standard. Prevention of adverse health effects for most workers from exposure to lead throughout a working lifetime requires that worker blood lead (PbB) levels be maintained at or below forty micrograms per one hundred grams of whole blood (40 ug/100 g). The blood lead levels of workers (both male and female workers) who intend to have children should be maintained below 30 ug/100 g to minimize adverse reproductive health effects to the parents and to the developing fetus.

The measurement of your blood lead level is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels (PbB) are most often reported in units of milligrams (mg) or micrograms (ug) of lead (1 mg = 1000 ug) per 100 grams (100 g), 100 milliliters (100 ml) or deciliter (dl) of blood. These three units are essentially the same. Sometimes PbB's are expressed in the form of mg% or ug%. This is a shorthand notation for 100 g, 100 ml. or dl.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment of disease.

Once your blood lead level climbs above 40 ug/100 g, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Studies have associated fatal encephalopathy with PbBs as low as 150 ug/100 g. Other studies have shown other forms of diseases in some workers with PbBs well below 80 ug/100 g. Your PbB is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have had elevated PbB, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage.

The best way to prevent all forms of lead-related impairments and diseases—both short term and long term—is to maintain your PbB below 40 ug/100 g. The provisions of the standard are designed with this end in mind. Your employer has prime responsibility to assure that the provisions of the standard are complied with both by the company and by individual workers.

You as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his actions.

(4) Reporting signs and symptoms of health problems. You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead on your ability to have a healthy child. You should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place.

APPENDIX B
EMPLOYEE STANDARD SUMMARY

Contents:

This appendix summarizes key provisions of the standard that you as a worker should become familiar with.

I. Permissible Exposure Limit (PEL)

The standard sets a permissible exposure limit (PEL) of fifty micrograms of lead per cubic meter of air (50 ug/m^3), averaged over an 8-hour work-day. This is the highest level of lead in air to which you may be permissibly exposed over an 8-hour workday. Since it is an 8-hour average, it permits short exposures above the PEL so long as for each 8-hour work day your average exposure does not exceed the PEL.

This standard recognizes that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be 40 ug/m^3.

II. Exposure Monitoring

If lead is present in the workplace where you work in any quantity, your employer is required to make an initial determination of whether the action level is exceeded for any employee. This initial determination must include instrument monitoring of the air for the presence of lead and must cover the exposure of a representative number of employees who are reasonably believed to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past year he may use these results. If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead this must also be considered as part of the initial determination. This initial determination must have been completed by Feb. 19, 1981. If this initial determination shows that a reasonable possibility exists that <u>any</u> employee may be exposed, without regard to respirators, over the action level (30 ug/m^3) your employer must set up an air monitoring program to determine the exposure level of every employee exposed to lead at your workplace.

In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represented by at least one full shift (at least 7 hours) air sample. In addition, these air samples must be taken under conditions which represent each employee's <u>regular</u>, daily exposure to lead. All initial exposure monitoring must have been completed by March 21, 1981.

If you are exposed to lead and air sampling is performed, your employer is required to quickly notify you in writing of air monitoring results which represent your exposure. If the results indicate your exposure exceeds the PEL (without regard to your use of respirators), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring every six months if your exposure is over the action level but below the PEL. Air monitoring must be repeated every three months if you are exposed over the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at least two weeks apart, are below the action level. However, whenever there is a production, process, control, or personnel change at your workplace which may result in new or additional exposure to lead, or whenever there is any other reason to suspect a change which may result in new or additional exposure to lead, your employer must perform additional monitoring.

III. Methods of Compliance.

Your employer is required to assure that no employee is exposed to lead in excess of the PEL. The standard establishes a priority of methods to be used to meet the PEL including the use of engineering and work practice controls and respirators.

IV. Respiratory Protection

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide you a respirator even if your air exposure level does not exceed the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the seven types listed in Table 2 of the Respiratory Protection section of the standard (R 325.51917). Any respirator chosen must be approved by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 42 CFR part 84. This respirator selection table will enable your employer to choose a type of respirator that will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air-purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear. A PAPR has a filter, cartridge or canister to clean the air, and a power

source which continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden of having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request. Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators.

Your employer must ensure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical to your protection from airborne lead. Obtaining a proper fit on each employee may require your employer to make available several different types of respirator masks. To ensure that your respirator fits properly and that facepiece leakage is minimal, your employer must give you either a qualitative or qualitative fit test as specified in Appendix A of the Respiratory Protection standard located at 29 CFR 1910.134 which was adopted by reference in the Michigan Occupational Health Standard Part 451. Respiratory Protection, R 325.60051 et seq.

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you how to wear a respirator, to know why it is needed, and to understand its limitations.

V. Protective Work Clothing and Equipment.

If you are exposed to lead above the PEL or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with protective clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 ug/m^3. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing repairs and replacement as necessary, and is also responsible for the cleaning, laundering or disposal of protective clothing and equipment. Contaminated work clothing or equipment must be removed in change rooms and not worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room. At no time may lead be removed from protective clothing or equipment by any means which disperses lead into the workroom air.

VI. Housekeeping.

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is absolutely prohibited. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used and emptied in a manner which minimizes the reentry of lead into the workplace.

VII. Hygiene Facilities and Practices.

The standard requires that change rooms, showers, and filtered air lunchrooms be constructed and used by workers exposed to lead in excess of the PEL. When the PEL is exceeded, the employer must assure that food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in these facilities. Change rooms, showers, and lunchrooms, must be used by workers exposed in excess of the PEL. After showering, no clothing or equipment worn during the shift may be worn home, and this includes shoes and underwear. Your own clothing worn during the shift should be carried home and cleaned carefully so that it does not contaminate your home. Lunchrooms may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking, or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

VIII. Medical Surveillance.

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have effectively protected you as an individual. Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect individual workers (1) who have high body burdens of lead acquired over past years, (2) who have additional, uncontrolled sources of non-occupational lead exposure, (3) who exhibit unusual variations in lead absorption rates, or (4) who have specific non-work related medical conditions which could be aggravated by lead exposure (e.g. renal disease, anemia). In addition, control systems may fail, or hygiene and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability—regardless of whether you are a man or woman.

All medical surveillance required by the standard must be preformed by or under the supervision of a licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts—periodic biological monitoring and medical examinations.

Your employer's obligation to offer you medical surveillance is triggered by the results of the air monitoring program. Medical surveillance must be made available to all employees who are exposed in excess of the action level for more than 30 days a year. The initial phase of the medical surveillance program, which includes blood lead level tests and medical examinations, must be completed for all covered employees no later than March 21, 1981. Priority within this first round of medical surveillance must be given to employees whom the employer believes to be at greatest risk from continued exposure (for example, those with the longest prior exposure to lead, or those with the highest current exposure). Thereafter, the employer must

periodically make medical surveillance—both biological monitoring and medical examinations—available to all covered employees.

Biological monitoring under the standard consists of blood lead level (PbB) and zinc protoporphyrin tests at least every 6 months after the initial PbB test. A zinc protoporphyrin (ZPP) test is a very useful blood test which measures an effect of lead on your body. If a worker's PbB exceeds 40 ug/100 g the monitoring frequency must be increased from every 6 months to at least every 2 months and not reduced until two consecutive PbBs indicate a blood lead level below 40 ug/100 g. Each time your PbB is determined to be over 40 ug/100 g, your employer must notify you of this in writing within five working days of his receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic protection when your PbB exceeds certain criteria (See Medical Removal Protection). During the first year of the standard, this removal criterion is 70 ug/100 g. Anytime your PbB exceeds 70 ug/100 g your employer must make available to you a prompt follow-up PbB test to ascertain your PbB. If the two tests both exceed 70 ug/100 g and you are temporarily removed, then your employer must make successive PbB tests available to you on a monthly basis during the period of your removal.

Medical examinations beyond the initial one must be made available on an annual basis if your blood lead level exceeds 40 ug/100 g at any time during the preceding year. The initial examination will provide information to establish a baseline to which subsequent data can be compared. An initial medical examination must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under the medical removal protection provisions of the standard (See Part IX, below).

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician. Pre-assignment and annual medical examinations must include (1) a detailed work history and medical history, (2) a thorough physical examination, and (3) a series of laboratory tests designed to check your blood chemistry and your kidney function. In addition, at any time upon your request, a laboratory evaluation of male fertility will be made (microscopic examination of a sperm sample), or a pregnancy test will be given.

The standard does not require that you participate in any of the medical procedures, test, etc. which your employer is required to make available to you. Medical surveillance can, however, play a very important role in protecting your health. You are strongly encouraged, therefore, to participate in a meaningful fashion. The standard contains a multiple physician review mechanism which would give you a chance to have a physician of your choice directly participate in the medical surveillance program. If you were dissatisfied with an examination by a physician chosen by your employer, you could select a second physician to conduct an independent analysis. The two doctors would attempt to resolve any differences of opinion, and select a third physician to resolve any firm dispute. Generally your employer will choose the physician who conducts medical surveillance under the lead standard—unless you and your employer can agree on the choice of a physician or physicians. Some companies and unions have agreed in advance, for example, to use certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as required medical surveillance is made available to workers.

The standard requires your employer to provide certain information to a physician to aid his or her examination of you. This information includes (1) the standard and its appendices, (2) a description of your duties as they relate to lead exposure, (3) your exposure level, (4) a description of personal protective equipment you wear, (5) prior blood level results, and (6) prior written medical opinions concerning you that the employer has. After a medical examination or consultation the physician must prepare a written report which must contain (1) the physician's opinion as to whether you have any medical condition which places you at risk of material impairment to health from exposure to lead, (2) any recommended special protective measures to be provided to you, (3) any blood lead level determinations, and (4) any recommended limitation on your use of respirators. This last element must include a determination of whether you can wear a powered air purifying respirator (PAPR) if you are found unable to wear a negative pressure respirator.

The medical surveillance program of the lead standard may at some point in time serve to notify certain workers that they have acquired a disease or other adverse medical condition as a result of occupational lead exposure. If this is true, these workers might have legal rights to compensation from the public agencies, their employers, firms that supply hazardous products to their employers, or other persons. The Bureau of Worker Compensation or an attorney can be consulted about these possibilities. It should be stressed that the Michigan Department of Public Health (MDPH) is in no way trying to either encourage or discourage claims or lawsuits. However, since results of the standard's medical surveillance program can significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for MDPH to make you aware of this.

The medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for the treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents. The medical community has balanced the advantages and disadvantages resulting from the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted imitations due to a history of abuse of chelation therapy by some lead companies. The most widely used chelating agents are Calcium Disodium EDTA, ($CaNa_2EDTA$), Calcium Disodium Versenate (Versenate), and d-penicillamine (pencillamine or Cupramine).

The standard prohibits "prophylactic chelation" of any employee by any person the employer retains, supervises or controls. "Prophylactic chelation" is the routine use of chelating or similarly acting drugs to prevent elevated blood levels in workers who are occupationally exposed to lead, or the use of drugs to routinely lower blood lead levels to predesignated concentrations believed to be "safe". It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level, that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard allows the use of "therapeutic" or "diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involved giving a patient a dose of the drug then collecting all urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

IX. Medical Removal Protection.

Excessive lead absorption subjects you to increased risk of disease. Medical removal protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to provide the protection you need. MRP involves the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. Up to eighteen months of protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eighteen month period expires. The standard contains special provisions to deal with the extraordinary but possible case where a long term worker's blood lead level does not adequately decline during eighteen months of removal.

During the first year of the standard if your blood lead level is 70 ug/100 g or above, you must be removed from any exposure where your air lead level without a respirator would be 100 ug/m^3 or above. If you are removed from your normal job, you may not be returned until your blood lead level declines to at least 50 ug/100 g. These criteria for removal and return will change according to the following schedule:

Removal blood lead (ug/100g)		**Air lead (ug/m^3)**	**Return blood lead (ug/100 g)**
Beginning Jan. 20, 1981	70 and above	50 and above	at or below 50
Beginning Jan. 20, 1982	60 and above	30 and above	at or below 40
Beginning Jan. 20, 1984	50 and above averaged over six months	30 and above	at or below 40

You may also be removed from exposure even if your blood lead levels are below these criteria if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employers medical program makes a final written opinion recommending your removal or other special protective measures, your employer must implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situations, MRP benefits must be provided during the period of removal—i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings includes more than just your basic wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow-up medical surveillance, you may loose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not

been removed. If you would still be in your old job if no removal had occurred, that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for lost wages, your employer's MRP benefits obligation is reduced by the amount that you actually receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer voluntarily removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not require removal. In these situations MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer to a low exposure job, or to a lay-off with MRP benefits.

X. Employee Information and Training.

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead. This program must inform these employees of the specific hazards associated with their work environment, protective measures which can be taken, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. In addition, your employer must make readily available to all employees, including those exposed below the action level, a copy of the standard and its appendices and must distribute to all employees any materials provided to the employer by the Michigan Department of Public Health.

Your employer is required to complete this training program for all employees by March 21, 1981. After this date, all new employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter.

XI. Signs.

The standard requires that the following warning sign be posted in work areas where the exposure to lead exceeds the PEL:

WARNING

LEAD WORK AREA

NO SMOKING OR EATING

XII. Recordkeeping.

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytic techniques, the results of this sampling, and the type of the respiratory protection being worn by the person sampled. Your employer is also required to keep all records of biological monitoring and medical examination results. These must include the names of the employees, the physician's written opinion, and a copy of the results of the examination. All of the above kinds of records must be kept for 40 years, or for at least 20 years after your termination of employment, whichever is longer.

Recordkeeping is also required if you are temporarily removed from your job under the medical protection program. This record must include your name and social security number, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than PbB's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personnel medical records unless you authorize their access.

XIII. Observation of Monitoring.

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to an explanation of the measurement procedure, and to record results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn by employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

XIV. Effective Date.

The standard's initial effective date is Jan. 20, 1981, and employer obligations under the standard begin to come into effect as of that date.

XV. For Additional Information.

Copies of the standard and explanatory materials can be obtained free of charge by calling or writing the Division of Consumer and Industry Services, 7150 Harris Drive, P.O. Box 30643, Lansing, Michigan 48909-8143

APPENDIX C
MEDICAL SURVEILLANCE
INFORMATION

Contents:

The purpose of this document is to outline the medical surveillance provisions of the standard for inorganic lead, and to provide further information to the physician regarding the examination and evaluation of workers exposed to inorganic lead.

Section 1 provides a detailed description of the monitoring procedure including the required frequency of blood testing for exposed workers, provisions for medical removal protection (MRP), the right of an employee to a second medical opinion, and notification and recordkeeping requirements of the employer. A discussion of the requirements for respirator use and respirator monitoring and MIOSHA's position on prophlactic chelation therapy are also included in this section.

Section 2 discusses the toxic effects and clinical manifestations of lead poisoning and effects of lead intoxication on enzymatic pathways in heme synthesis. The adverse effects on both male and female reproductive capacity and on the fetus are also discussed.

Section 3 outlines the recommended medical evaluation of the worker exposed to inorganic lead including details of the medical history, physical examination, and recommended laboratory tests, which are based on the toxic effects of lead as discussed in Section 2.

Section 4 provides detailed information concerning the laboratory tests available for the monitoring of exposed workers. Included also is a discussion of the relative value of each test and the limitations and precautions which are necessary in the interpretation of the laboratory results.

I. Medical surveillance and monitoring requirements for workers exposed to inorganic lead.

Under the occupational health standard for inorganic lead, a program of biological monitoring and medical surveillance is to be made available to all employees exposed to lead above the action level of 30 ug/m^3 TWA for more than 30 days each year. This program consists of periodic blood sampling and medical evaluation to be performed on a schedule which is defined by previous laboratory results, worker complaints or concerns, and the clinical assessment of the examining physician.

Under this program, the blood lead and zinc protoporphyrin (ZPP) levels of all employees who are exposed to lead above the action level of 30 ug/m^3 is to be determined at least every six months. The frequency is increased to every two months for employees whose last blood lead level was between 40 ug/100 g whole blood and the level requiring employee medical removal to be discussed below. For employees who are removed from exposure to lead due to an elevated blood lead, a new blood lead and ZPP levels must be measured monthly. A zinc protoporphyrin (ZPP) measurement is strongly recommended on each occasion that a blood lead level measurement is made.

An annual medical examination and consultation performed under the guidelines discussed in Section III is to be made available to each employee for whom a blood test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 ug/100 g. Also, an examination is to be given to all employees prior to their assignment to an area in which airborne lead concentrations reach or exceed the action level. In addition, a medical examination must be provided as soon as possible after notification by an employee that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice regarding lead exposure and the ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during respirator use. An examination is also to be made available to each employee removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited or specially protected pursuant to medical recommendations.

Results of biological monitoring or the recommendations of an examining physician may necessitate removal of an employee from further lead exposure pursuant to the standard's medical removal protection (MRP) program. The object of the MRP program is to provide temporary medical removal to workers either with substantially elevated blood lead levels or otherwise at risk of sustaining material health impairment from continued substantial exposure to lead. The following guidelines which are summarized in Table 1 were created under the standard for the temporary removal of an exposed employee and his or her subsequent return to work in an exposure area.

Table 1

A. Blood lead level requiring employee medical removal (Level must be confirmed with second follow-up blood lead level within two weeks of first report.)	≥ 60 ug/100 g or average of last three blood samples or all blood samples over previous 6 months (whichever is over a longer period) - 50 ug/100 g or greater unless last blood sample is 40 ug/100 g or less.
B. Frequency which employees exposed to action level of lead (30 ug/m^3 TWA) must have blood lead and ZPP levels checked.	
1. Last blood lead level less than 40 ug/100 g	Every 6 months
2. Last blood lead level between 40 ug/100 g and level requiring medical removal (See A above)	Every 2 months
3. Employees removed from exposure to lead because of an elevated blood lead level	Every 1 month
C. Permissible airborne exposure limit for workers removed from work due to an elevated blood lead level (without regard to respirator protection).	30 ug/m^3 8 hour TWA
D. Blood lead level confirmed with a second blood analysis at which employee may return to work. Permissible exposure without regard to respirator protection is listed by industry in Table 1 of the standard.	≤ 40 ug/100 g

NOTE: When medical opinion indicates that an employee is at risk of material impairment from exposure to lead, the physician can remove an employee from exposures exceeding the action level (or less) or recommend special protective measures as deemed appropriate and necessary. Medical monitoring during the medical removal period can be more stringent than noted in the table above if the physician so specifies. Return to work or removal of limitations and special protections is permitted when the physician indicates that the worker is no longer at risk of material impairment.

Under the standard's ultimate worker removal criteria, a worker is to be removed from any work having any eight hour TWA exposure to lead of 30 ug/m^3 or more whenever either of the following circumstances apply: (1) a blood lead level of 60 ug/100 g or greater is obtained and confirmed by a second follow-up blood lead level performed within two weeks after the employer receives the results of the first blood sampling test, or (2) the average of the previous three blood lead determinations or the average of all blood lead determinations conducted during the previous six months, whichever encompasses the longest time period, equals or exceeds 50 ug/100 g, unless the last blood sample indicates a blood lead level at or below 40 ug/100 g in which case the employee need not be removed. Medical removal is to continue until two consecutive blood lead levels are 40 ug/100 g or less.

As part of the standard, the employer is required to notify in writing each employee whose blood lead level exceeds 40 ug/100 g. In addition each such employee is to be informed that the standard requires medical removal with MRP benefits, discussed below, when an employee's blood lead level exceeds the above defined limits.

In addition to the above blood lead level criteria, temporary worker removal may also take place as a result of medical determinations and recommendations. Written medical opinions must be prepared after each examination pursuant to the standard. If the examining physician includes a medical finding, determination or opinion that the employee has a medical condition which places the employee at increased risk of material health impairment from exposure to lead, then the employee must be removed from exposure to lead at or above the action level. Alternatively, if the examining physician recommends special protective measures for an employee (e.g., use of a powered air purifying respirator) or recommends limitations on an employee's exposure to lead, then the employer must implement these recommendations. Recommendations may be more stringent than the specific provisions of the standard. The examining physician, therefore, is given broad flexibility to tailor special protective procedures to the needs of individual employees. This flexibility extends to the evaluation and management of pregnant workers and male and female workers who are planning to raise children. Based on the history, physical examination, and laboratory studies, the physician might recommend special protective measures or medical removal for an employee who is planning to conceive a child when, in the physician's judgement, continued exposure to lead at the current job would pose a significant risk. The return of the employee to his or her former job status, or the removal of special protections or limitations, depends upon the examining physician determining that the employee is no longer at

increased risk of material impairment or that special measures are no longer needed.

During the period of any form of special protection or removal, the employer must maintain the worker's earnings, seniority, and other employment rights and benefits (as though the worker had not been removed) for a period of up to 18 months. This economic protection will maximize meaningful worker participation in the medical surveillance program, and is appropriate as part of the employer's overall obligation to provide a safe and healthful workplace. The provisions of MRP benefits during the employee's removal period may, however, be conditioned upon participation in medical surveillance.

On rare occasions, an employee's blood lead level may not acceptably decline within 18 months of removal. This situation will arise only in unusual circumstances, thus the standard relies on an individual medical examination to determine how to protect such an employee. This medical determination is to be based on both laboratory values, including lead levels, zinc protoporphyrin levels, blood counts, and other tests felt to be warranted, as well as the physician's judgement that any symptoms or findings on physical examination are a result of lead toxicity. The medical determination may be that the employee is incapable of ever safely returning to his or her former job status. The medical determination may provide additional removal time past 18 months for some employees or specify special protective measures to be implemented.

The lead standard provides for a multiple physician review in cases where the employee wishes a second opinion concerning potential lead poisoning or toxicity. If an employee wishes a second opinion, he or she can make an appointment with a physician of his or her choice. This second physician will review the findings, recommendations or determinations of the first physician and conduct any examinations, consultations or tests deemed necessary in an attempt to make a final medical determination. If the first and second physicians do not agree in their assessment they must try to resolve their differences. If they cannot reach an agreement then they must designate a third physician to resolve the dispute.

The employer must provide examining and consulting physicians with the following specific information: a copy of the lead regulations and all appendices, a description of the employee's duties as related to exposure, the exposure level to lead and any other toxic substances (if applicable), a description of personal protective equipment used, blood lead levels, and all prior written medical opinions regarding the employee in the employer's possession or control. The employer must also obtain from the physician and provide the employee with a written medical opinion containing blood lead levels, the physician's opinion as to whether the employee is at risk of material impairment to health, any recommended protective measures for the employee if further exposure is permitted, as well as any recommended limitations upon an employee's use of respirators.

Employers must instruct each physician not to reveal to the employer in writing or in any other way his or her findings, laboratory results, or diagnoses which are felt to be unrelated to occupational lead exposure. They must also instruct each physician to advise the employee of any occupationally or non-occupationally related medical condition requiring further treatment or evaluation.

The standard provides for the use of respirators where engineering and other primary controls have not been fully implemented. However, the use respirator protection shall not be used in lieu of temporary medical removal due to elevated blood lead levels or findings that an employee is at risk of material health impairment. This is based on the numerous inadequacies of respirators including skin rash where the facepiece makes contact with the skin, unacceptable stress to breathing in some workers with underlying cardiopulmonary impairment, difficulty in providing adequate fit, the tendency for respirators to create additional hazards by interfering with vision, hearing, and mobility, and the difficulties of assuring the maximum effectiveness of a complicated work practice program involving respirators. Respirators do, however, serve a useful function where engineering and work practice controls are inadequate by providing supplementary, interim, or short-term protection, provided they are properly selected for the environment in which the employee will be working, properly fitted to the employee, maintained and cleaned periodically, and worn by the employee when required.

In its final standard on occupational exposure to inorganic lead, MIOSHA has prohibited prophylactic chelation. Diagnostic and therapeutic chelation are permitted only under the supervision of a licensed physician with appropriate medical monitoring in an acceptable clinical setting. The decision to initiate chelation therapy must be made on an individual basis and take into account the severity of symptoms felt to be a result of lead toxicity along with blood lead levels, ZPP levels, and other laboratory tests as appropriate. EDTA and penicillamine which are the primary chelating agents used in the therapy of occupational lead poisoning have significant potential side effects and their use must be justified on the basis of expected benefits to the worker. Unless frank and severe symptoms are present, therapeutic chelation is not recommended given the opportunity to remove a worker from exposure and allow the body to naturally excrete accumulated lead. As a diagnostic aid, the chelation mobilization test using the CA-EDTA has limited applicability. According to some investigators, the test can differentiate between lead-induced and other nephropathies. The test may also provide an estimation of the mobile fraction of the total body lead burden.

Employers are required to assure that accurate records are maintained on exposure monitoring, medical surveillance, and medical removal for each employee. Exposure monitoring and medical surveillance records must be kept for 40 years or the duration of employment plus 20 years, whichever is longer, while medical removal records must be maintained for the duration of employment. All records required under the standard must be available upon request to the Michigan Department of Consumer and Industry Services and the Director of the National Institute for Occupational Safety and Health. Employers must also make environmental and biological monitoring and medical removal records available to affected employees and to former employees or their authorized employee representatives. Employees or their specifically designated representatives have access to their entire medical surveillance records.

In addition, the standard requires that the employer inform all workers exposed to lead at or above the action level of the provisions of the standard and all of its appendices, the purpose and description of medical surveillance and provisions for medical removal protection if temporary medical removal is required. An understanding of the potential health effects of lead exposure by all exposed employees along with full understanding of their rights under the lead standard is essential for an effective monitoring program.

II. Adverse health effects of inorganic lead.

Although the toxicity of lead has been known for 2,000 years, the knowledge of the complex relationship between lead exposure and human response is still being refined. Significant research into the toxic properties of lead continues throughout the world, and it should be anticipated that our understanding of thresholds of effects and margins of safety will be improved in future years. The provisions of the lead standard are founded on two prime medical judgments: first, the prevention of adverse health effects from exposure to lead throughout a working lifetime requires that worker blood lead levels be maintained at or below 40 ug/100 g and second, the blood lead levels of workers, male or female, who intend to parent in the near future should be maintained below 30 ug/100 g to minimize adverse reproductive health effects to the parents and developing fetus. The adverse effects of lead on reproduction are being actively researched and MIOSHA encourages the physician to remain abreast of recent developments in the area to best advise pregnant workers or workers planning to conceive children.

The spectrum of health effects caused by lead exposure can be subdivided into five developmental stages: normal, physiological changes of uncertain significance, pathophysiological changes, overt symptoms (morbidity), and mortality. Within this process there are no sharp distinctions, but rather a continuum of effects. Boundaries between categories overlap due to the wide variation of individual responses and exposures in the working population. MIOSHA's development of the lead standard focused on pathophysiological changes as well as later stages of disease.

1. Heme Synthesis Inhibition. The earliest demonstrated effect of lead involves its ability to inhibit at least two enzymes of the heme synthesis pathway at very low blood levels. Inhibition of delta aminolevulinic acid dehydrase (ALA-D) which catalyzes the conversion of delta-aminolevulinic acid (ALA) to protoporphyrin is observed at a blood lead level below 20 ug/100 g whole blood. At a blood lead level of 40 ug/100 g, more than 20% of the population would have 70% inhibition of ALA-D. There is an exponential increase in ALA excretion at blood lead levels greater than 40 ug/100 g.

Another enzyme, ferrochelatase, is also inhibited at low blood lead levels. Inhibition of ferrochelatase lead to increased free erythrocyte protoporphyrin (FEP) in the blood which can then bind to zinc to yield zinc protoporphyrin. At a blood lead level of 50 ug/100 g or greater, nearly 100% of the population will have an increase in FEP. There is also an exponential relationship between blood lead levels greater than 40 ug/100 g and the associated ZPP level, which has led to the development of the ZPP screening test for lead exposure.

While the significance of these effects is subject to debate, it is MIOSHA's position that these enzyme disturbances are early stages of a disease process which may eventually result in the clinical symptoms of lead poisoning. Whether or not the effects do progress to the later stages of clinical disease, disruption of these enzyme processes over a working lifetime is considered to be a material impairment of health.

One of the eventual results of lead-induced inhibition of enzymes in the heme synthesis pathway is anemia which can be asymptomatic if mild but associated with a wide array of symptoms including dizziness, fatigue, and tachycardia when more severe. Studies have indicated that lead levels as low as 50 ug/100 g can be associated with a definite decreased hemoglobin, although most cases of lead-induced anemia, as well as shortened red-cell survival times, occur at lead levels exceeding 80 ug/100 g. Inhibited hemoglobin synthesis is more common in chronic cases whereas shortened erythrocyte life span is more common in acute cases.

In lead-induced anemia, there is usually a reticulocytosis along with the presence of basophilic stippling, and ringed sideroblasts, although none of the above are pathognomonic for lead-induced anemia.

2. Neurological Effects. Inorganic lead has been found to have toxic effects on both the central and peripheral nervous systems. The earliest stages of lead-induced central nervous system effects first manifest themselves in the form of behavioral disturbances and central nervous system symptoms including irritability, restlessness, insomnia and other sleep disturbances, fatigue, vertigo, headache, poor memory, tremor, depression, and apathy. With more severe exposure, symptoms can progress to drowsiness, stupor, hallucinations, delirium, convulsions and coma.

The most severe and acute form of lead poisoning which usually follows ingestion of inhalation of large amounts of lead is acute encephalopathy which may arise precipitously with the onset of intractable seizures, coma, cardiorespiratory arrest, and death within 48 hours.

While there is disagreement about what exposure levels are needed to produce the earliest symptoms, most experts agree that symptoms definitely can occur at blood lead levels of 60 ug/100 g whole blood and therefore recommend a 40 ug/100 g maximum. The central nervous system effects frequently are not reversible following discontinued exposure of chelation therapy and when improvement does occur, it is almost always only partial.

The peripheral neuropathy resulting from lead exposure characteristically involves only motor function with minimal sensory damage and has a marked predilection for the extensor muscles of the most active extremity. The peripheral neuropathy can occur with varying degrees of severity. The earliest and mildest form which can be detected in workers with blood lead levels as low as 50 ug/100 g is manifested by slowing of motor nerve conduction velocity often without clinical symptoms. With progression of the neuropathy there is development of painless extensor muscle weakness usually involving the extensor muscles of the fingers and hand in the most active upper extremity, followed in severe cases by wrist drop or, much less commonly, foot drop.

In addition to slowing of nerve conduction, electromyographical studies in patients with blood lead levels greater than 50 ug/100 g have demonstrated a decrease in the number of acting motor unit potentials, an increase in the duration of motor potentials, and spontaneous pathological activity including fibrillations and fasciculations. Whether these effects occur at levels of 40 ug/100 g is undetermined.

While the peripheral neuropathies can occasionally be reversed with therapy, again such recovery is not assured particularly in the more severe neuropathies and often improvement is only partial. The lack of reversibility is felt to be due in part to segmental demyelination.

3. Gastrointestinal. Lead may also affect the gastrointestinal system producing abdominal colic of diffuse

abdominal pain, constipation, obstipation, diarrhea, anorexia, nausea and vomiting. Lead colic rarely develops at blood lead levels below 80 ug/100 g.

4. Renal. Renal toxicity represents one of the most serious health effects of lead poisoning. In the early stages of disease nuclear inclusion bodies can frequently be identified in proximal renal tubular cells. Renal function remains normal and the changes in this stage are probably reversible. With more advanced disease there is progressive interstitial fibrosis and impaired renal function. Eventually extensive interstitial fibrosis ensues with sclerotic glomeruli and dilated and atrophied proximal tubules; all represent end stage kidney disease. Azotemia can be progressive, eventually resulting in frank uremia necessitating dialysis. There is occasionally associated hypertension and hyperuricemia with or without gout.

Early kidney disease is difficult to detect. The urinalysis is normal in early lead nephropathy and the blood urea nitrogen and serum creatinine increase only when two-thirds of the kidney function is lost. Measurement of creatinine clearance can often detect earlier disease as can other methods of measurement of glomerular filtration rate. An abnormal Ca-EDTA mobilization test has been used to differentiate between lead-induced and other nephropathies, but this procedure is not widely accepted. A form of Fanconi syndrome with aminoaciduria, glycosuria, and hyperphosphaturia indicating severe injury to the proximal renal tubules is occasionally seen in children.

5. Reproductive Effects. Exposure to lead can have serious effects on reproductive function in both males and females. In male workers exposed to lead there can be a decrease in sexual drive, impotence, decreased ability to produce healthy sperm, and sterility. Malformed sperm (teratospermia), decreased number of sperm (hypospermia), and sperm with decreased motility (asthenospermia) can all occur. Teratospermia has been noted at mean blood lead levels of 53 ug/100 g and hypospermia and asthenospermia at 41 ug/100 g. Furthermore, there appears to be a dose-response relationship for teratospermia in lead exposed workers.

Women exposed to lead may experience menstrual disturbances including dysmenorrhea, menorrhagia and amenorrhea. Following exposure to lead, women have a higher frequency of sterility, premature births, spontaneous miscarriages, and stillbirths.

Germ cells can be affected by lead and cause genetic damage in the egg or sperm cells before conception and result in failure to implant, miscarriage, stillbirth, or birth defects.

Infants of mothers with lead poisoning have a higher mortality during the first year and suffer from lower birth weights, slower growth, and nervous system disorders.

Lead can pass through the placental barrier and lead levels in the mother's blood are comparable to concentrations of lead in the umbilical cord at birth. Transplacental passage becomes detectable at 12-14 weeks of gestation and increases until birth.

There is little direct data on damage to the fetus from exposure to lead but it is generally assumed that the fetus and newborn would be at least as susceptible to neurological damage as young children. Blood lead levels of 50-60 ug/ 100 g in children can cause significant neurobehavioral impairments and there is evidence of hyperactivity at blood lead levels as low as 25 ug/100 g. Given the overall body of literature concerning the adverse health effects of lead in children, MIOSHA feels that the blood lead level in children should be maintained below 30 ug/100 g with a population mean of 15 ug/100 g. Blood lead levels in the fetus and newborn likewise should not exceed 30 ug/100 g.

Because of lead's ability to pass through the placental barrier and also because of the demonstrated adverse effects of lead on reproductive function in both male and female as well as the risk of genetic damage of lead on both the ovum and sperm, MIOSHA recommends a 30 ug/100 g maximum permissible blood lead level in both males and females who wish to bear children.

6. Other Toxic Effects. Debate and research continue on the effects of lead on the human body. Hypertension has frequently been noted in occupationally exposed individuals although it is difficult to assess whether this is due to lead's adverse effects on the kidney or if some other mechanism is involved. Vascular and electrocardiographic changes have been detected but have not been well characterized. Lead is thought to impair thyroid function and interfere with the pituitary-adrenal axis, but again these effects have not been well defined.

III. Medical Evaluation.

The most important principle in evaluating a worker for any occupational disease including lead poisoning is a high index of suspicion on the part of the examining physician. As discussed in Section 2, lead can affect numerous organ systems and produce a wide array of signs and symptoms, most of which are non-specific and subtle in nature at least in the early stages of disease. Unless serious concern for lead toxicity is present, many of the early clues to diagnosis may easily be overlooked.

The crucial initial step in the medical evaluation is recognizing that a worker's employment can result in exposure to lead. The worker will frequently be able to define exposures to lead and lead containing materials but often will not volunteer this information unless specifically asked. In other situation the worker may not know of any exposures to lead but the suspicion might be raised on the part of the physician because of the industry or occupation of the worker. Potential occupational exposure to lead and its compounds occur in at least 120 occupations, including lead smelting, the manufacture of lead storage batteries, the manufacture of lead pigments and products containing pigments, solder manufacture, shipbuilding and ship repair, auto manufacturing, construction, and painting.

Once the possibility for lead exposure is raised, the focus can then be directed toward eliciting information from the medical history, physical exam, and finally from laboratory data to evaluate the worker for potential lead toxicity.

A complete and detailed work history is important in the initial evaluation. A listing of all previous employment with information on work processes, exposure to fumes or dust, known exposures to lead or other toxic substances, respiratory protection used, and previous medical surveillance should be included in the worker's record. Where exposure to lead is suspected, information concerning on-the-job personal hygiene, smoking or eating habits in work areas, laundry procedures, and use of any protective clothing or respiratory protection equipment should be noted. A complete work history is essential in the medical evaluation of a worker with suspected lead toxicity, especially when long term effects such as neurotoxicity and nephrotoxicity are considered.

The medical history is also of fundamental importance and should include a listing of all past and current medical conditions, current medications including propriety drug intake, previous surgeries and hospitalizations, allergies, smoking history, alcohol consumption, and also non-occupational lead exposures such as hobbies (hunting riflery). Also known childhood exposures should be elicited. Any previous history of hematological, neurological, gastrointestinal, renal, psychological, gynecological, genetic, or reproductive problems should be specifically noted.

A careful and complete review of systems must be performed to assess both recognized complaints and subtle or slowly acquired symptoms which the worker might not appreciate as being significant. The review of symptoms should include the following:

General - weight loss, fatigue, decreased appetite.

Head, Eyes, Ears, Nose, Throat (HEENT) - headaches, visual disturbances or decreased visual acuity, hearing deficits or tinnitus, pigmentation of the oral mucosa, or metallic taste in mouth.

Cardiopulmonary - shortness of breath, cough, chest pains, palpitations, or orthopnea.

Gastrointestinal - nausea, vomiting, heartburn, abdominal pain, constipation or diarrhea.

Neurologic - irritability, insomnia, weakness (fatigue), dizziness, loss of memory, confusion, hallucinations, incoordination, ataxia, decreased strength in hands or feet, disturbances in gait, difficulty in climbing stairs, or seizures.

Hematologic - pallor, easy fatigability, abnormal blood loss melena.

Reproductive (male and female and spouse where relevant) - history of infertility, impotence, loss of libido, abnormal menstrual periods, history of miscarriages, stillbirths, or children with birth defects.

Musculo-skeletal - muscle and joint pains.

The physical examination should emphasize the neurological, gastrointestinal, and cardiovascular systems. The worker's weight and blood pressure should be recorded and the oral mucosa checked for pigmentation characteristic of a possible Burtonian or lead line on the gingiva. It should be noted, however, that the lead line may not be present even in severe lead poisoning if good oral hygiene is practiced.

The presence of pallor on skin examination may indicate an anemia, which if severe might also be associated with tachycardia. If an anemia is suspected, an active search for blood loss should be undertaken including potential blood loss through the gastrointestinal tract.

A complete neurological examination should include an adequate mental status evaluation including a search for behavioral and psychological disturbances, memory testing, evaluation for irritability, insomnia, hallucinations, and mental clouding. Gait and coordination should be examined along with close observation for tremor. A detailed evaluation of peripheral nerve function including careful sensory and motor function testing is warranted. Strength testing particularly of extensor muscle groups of all extremities is of fundamental importance.

Cranial nerve evaluation should also be included in the routine examination.

The abdominal examination should include auscultation for bowel sounds and abdominal bruits and palpation for organomegaly, masses, and diffuse abdominal tenderness.

Cardiovascular examination should evaluate possible early signs of congestive heart failure. Pulmonary status should be addressed particularly if respirator protection is contemplated.

As part of the medical evaluation, the lead standard requires the following laboratory studies:

1. Blood lead level
2. Hemoglobin and hematocrit determinations, red cell indices, and examination of the peripheral blood smear to evaluate red blood cell morphology
3. Blood urea nitrogen
4. Serum creatinine
5. Routine urinalysis with microscopic examination
6. A zinc protoporphyrin level

In addition to the above, the physician is authorized to order any further laboratory or other tests which he or she deems necessary in accordance with sound medical practice. The evaluation must also include pregnancy testing or laboratory evaluation of male fertility if requested by the employee.

Additional tests which are probably not warranted on a routine basis but may be appropriate when blood lead and ZPP levels are equivocal include delta aminolevulinic acid and coproporphyrin concentrations in the urine, and dark-field illumination for detection of basophilic stippling in red blood cells.

If an anemia is detected, further studies including a careful examination of the peripheral smear, reticulocyte count, stool for occult blood, serum iron, total iron binding capacity, bilirubin, and, if appropriate, vitamin B_{12} and folate may be of value in attempting to identify the cause of the anemia.

If a peripheral neuropathy is suspected, nerve conduction studies are warranted both for diagnosis and as a basis to monitor any therapy.

If renal disease is questioned, a 24 hour urine collection for creatinine clearance, protein, and electrolytes may be indicated. Elevated uric acid levels may result from lead-induced renal disease and a serum uric acid level might be performed.

An electrocardiogram and chest x-ray may be obtained as deemed appropriate.

Sophisticated and highly specialized testing should not be done routinely and where indicated should be under the direction of a specialist.

IV. Laboratory Evaluation.

The blood lead level at present remains the single most important test to monitor lead exposure and is the test used in the medical surveillance program under the lead standard to guide employee medical removal. The ZPP has several advantages over the blood lead level. Because of its relatively recent development and the lack of extensive data

concerning its interpretation, the ZPP currently remains an ancillary test.

This section will discuss the blood lead level and ZPP in detail and will outline their relative advantages and disadvantages. Other blood tests currently available to evaluate lead exposure will also be reviewed.

The blood lead level is a good index of current or recent lead absorption when there is no anemia present and when the worker has not taken any chelating agents. However, blood lead levels along with urinary lead levels do not necessarily indicate the total body burden of lead and are not adequate measures of past exposure. One reason for this is that lead has a high affinity for bone and up to 90% of the body's total lead is deposited there. A very important component of the total lead body burden is lead in soft tissue (liver, kidney, and brain). This fraction of the lead body burden, the biologically active lead, is not entirely reflected by blood lead levels since it is a function of the dynamics of lead absorption, distribution, deposition in bone and excretion. Following discontinuation of exposure to lead, the excess body burden is only slowly mobilized from bone and other relatively stable body stores and excreted. Consequently, a high blood lead level may only represent recent heavy exposure to lead without a significant total body excess and likewise a low blood lead level does not exclude an elevated total body burden of lead.

Also due to its correlation with recent exposures, the blood lead level may vary considerably over short time intervals.

To minimize laboratory error and erroneous results due to contamination, blood specimens must be carefully collected after thorough cleaning of the skin with appropriate methods using lead-free blood containers and analyzed by a reliable laboratory. Under the standard, samples must be analyzed in laboratories which are approved by the Center for Disease Control (CDC) or which have received satisfactory grades in proficiency testing by the CDC in the previous year. Under CDC standards, 75% of blood lead determinations are not to vary from reference values by more than 15% or 6 ug/100 ml, which ever is greater. Analysis is to be made using atomic absorption spectrophotometry, anodic stripping voltammetry, or any method which meets the accuracy requirements set forth by the standard.

The determination of lead in urine is generally considered a less reliable monitoring technique than analysis of whole blood primarily due to individual variability in urinary excretion capacity as well as the technical difficulty of obtaining accurate 24 hour urine collections. In addition, workers with renal insufficiency, whether due to lead or some other cause, may have decreased lead clearance and consequently urine lead levels may underestimate the true lead burden. Therefore, urine lead levels should not be used as a routine test.

The zinc protoporphyrin test, unlike the blood lead determination, measures an adverse metabolic effect of lead and as such is a better indicator of lead toxicity than the level of blood lead itself. The level of ZPP reflects lead absorption over the preceding 3 to 4 months, and therefore is a better indicator of lead body burden. The ZPP requires more time than the blood lead to read significantly elevated levels; the return to normal after discontinuing lead exposure is also slower. Furthermore, the ZPP test is simpler, faster, and less expensive to perform and no contamination is possible. Many investigators believe it is the most reliable means of monitoring chronic lead absorption.

Zinc protoporphyrin results from the inhibition of the enzyme ferrochelatase which catalyzes the insertion of an iron molecule into the protoporphyrin molecule, which then becomes heme. If iron is not inserted into the molecule, then zinc, having a greater affinity for protoporphyrin, takes the place of the iron forming ZPP.

An elevation in the level of circulating ZPP may occur at blood lead levels as low as 20-30 ug/100 g in some workers. Once the blood lead level has reached 40 ug/100 g there is more marked rise in the ZPP value from its normal range of less than 100 ug/100 ml. Increases in blood lead levels beyond 40 ug/100 g are associated with exponential increases in ZPP.

Whereas blood lead levels fluctuate over short time spans, ZPP levels remain relatively stable. ZPP is measured directly in red blood cells and is present for the cell's entire 120 day life-span. Therefore, the ZPP level in blood reflects the average ZPP production over the previous 3-4 months and consequently the average lead exposure during that time interval.

It is recommended that a hematocrit be determined whenever a confirmed ZPP or 50 ug/100 ml whole blood is obtained to rule out a significant underlying anemia. If the ZPP is in excess of 100 ug/100 ml and not associated with abnormal elevations in blood lead levels, the laboratory should be checked to be sure that blood leads were determined using atomic absorption spectrophotometry, anodic stripping voltammetry, or any method which meets the accuracy requirements set forth by the standard by a CDC certified laboratory which is experienced in lead level determinations. Repeat periodic blood lead studies should be obtained in all individuals with elevated ZPP levels to be certain that an associated elevated blood lead level has not been missed due to transit fluctuations in blood leads.

ZPP has a characteristic fluorescence spectrum with a peak at 594 nm which is detectable with a hematofluorimeter. The hematofluorimeter is accurate and portable and can provide on-site, instantaneous results for workers who can be frequently tested via a finger prick.

However, careful attention must be given to calibration and quality control procedures. Limited data on blood lead/ ZPP correlations and the ZPP levels which are associated with the adverse health effects discussed in Section 2 are the major limitations of the test. Also it is difficult to correlate ZPP levels with environmental exposure and there is some variation of response with age and sex. Nevertheless, the ZPP promises to be an important diagnostic test for the early detection of lead toxicity and its value will increase as more data is collected regarding its relationship to other manifestations of lead poisoning.

Levels of delta-aminolevulinic acid (ALA) in the urine are also used as a measure of lead exposure. Increasing concentrations of ALA are believed to result from the inhibition of the enzyme delta-aminolevulinic acid dehydrase (ALA-D). Although the test is relatively easy to perform, inexpensive, and rapid, the disadvantages include variability in results, the necessity to collect a complete 24 hour urine sample which has a specific gravity greater than 1.010, and also the fact that ALA decomposes in the presence of light.

The pattern of porphyrin excretion in the urine can also be helpful in identifying lead intoxication. With lead poisoning, the urine concentrations of coproporphyrins

I and II, porphobilinogen and uroporphyrin I rise. The most important increase, however, is that of coproporphyrin

III; levels may exceed 5,000 ug/1 in the urine in lead poisoned individuals, but its correlation with blood lead levels and ZPP are not as good as those of ALA. Increases in urinary porphyrins are not diagnostic of lead toxicity and may be seen in porphyria, some liver diseases, and in patients with high reticulocyte counts.

Summary. The MIOSHA standard for inorganic lead places significant emphasis on the medical surveillance of all workers exposed to levels of inorganic lead above the action level of 30 ug/m^3 TWA. The physician has a fundamental role in this surveillance program, and in the operation of the medical removal protection program.

Even with adequate worker education on the adverse health effects of lead and appropriate training in work practices, personal hygiene and other control measures, the physician has a primary responsibility for evaluating potential lead toxicity in the worker. It is only through a careful and detailed medical and work history, a complete physical examination and appropriate laboratory testing that an accurate assessment can be made. Many of the adverse health effects of lead toxicity are either irreversible or only partially reversible and therefore early detection of disease is very important.

This document outlines the medical monitoring program as defined by the occupational safety and health standard for inorganic lead. It reviews the adverse effects of lead poisoning and describes the important elements of the history and physical examinations as they relate to these adverse effects. Finally, the appropriate laboratory testing for evaluating lead exposure and toxicity is presented.

It is hoped that this review and discussion will give the physician a better understanding of the MIOSHA standard with the ultimate goal of protecting the health and well-being of workers exposed to lead under his or her care.